Comparison of Significant PV Hot Spot Mitigation Techniques V120802

Bypass Diodes: Uses Diodes or FETs to pass current around a substring containing partially shaded cell(s).
HSS: Hot Spot Suppression; A calibrated model based method to limit low panel voltage to reduce cell reverse bias.
FOZHS: Forward Only Zero Hot Spot; An intrinsic properties based principle which prevents reverse bias.

Common Goals	Bypass Diodes	HSS	FOZHS
Limit maximum temperature to below EVA failure	Yes	Yes	Yes
Increase operating lifetime of solar panel	Yes	Yes	Yes
Limit the temperature of a hotspot	Yes	Yes	Yes
Permit arbitrarily long substrings	No	Yes	Yes
Provide a path around partially shaded substrings	Yes	No	Yes
Operate on a flash tester	Yes	No	Yes
Completely prevent a hot spot from forming due to mode, age or weathering	No	No	Yes
Prevent differential aging of partially shaded cells	No	No	Yes
Qualities			
Provable safe limit to reverse bias	Yes	No	Yes
Provable safe limit to peak temperature	No	No	Yes
Partially shaded cells get cooler	No	No	Yes
Cells are always forward biased	No	No	Yes
Insensitive to cell Reverse Breakdown Voltage	No	No	Yes
Insensitive to changes in cell shunt resistance (Dark Current)	Yes	No	Yes
Insensitive to changes in cell series resistance	Yes	No	Yes
Insensitive to non-linear shunts	No	No	Yes
Insensitive to shorted cells	Yes	No	Yes
Protects with pre-existing micro crack	No	No	Yes
Protects as a new micro crack forms	No	No	Yes
Protects with new micro cracks	No	No	Yes
Protects with large temperature gradients across the panel	Yes	No	Yes
Protects on flash tester	Yes	No	Yes
Optimistic Assumptions			
Relies on a flash tester calibrated model of each individual solar panel	No	Yes	No
Assumes electrical cell specs do not change due to age or weathering	No	Yes	No
Relies on known cell count of each individual solar panel	Yes	Yes	No
Relies on temperature measurement of each individual solar panel	No	Yes	No
Relies on temperature being uniform across entire panel and within each cell	No	Yes	No
Relies on known shunt resistance of each individual solar panel	No	Yes	No
Relies on known series resistance of each individual solar panel	No	Yes	No
Dirt will be uniformly distributed over panel and panels will be kept clean	No	Yes	No
Panel will not be installed near vent pipes or other permanent obstructions	Yes	Yes	No
That sub strings are not necessary to mitigate partial shade production	No	Yes	No
Pessimistic Assumptions			
Assumes number of cells may change over the life of the panel due to repair	No	No	Yes
Assumes every electrical characteristic may change due to age and weathering	No	No	Yes
Assumes micro-cracks will form as part of the weathering process	No	No	Yes
Assumes micro-cracks will form during UL/IEC humidity freeze test	No	No	Yes
Assumes micro-cracks will form during UL/IEC snow load test	No	No	Yes
Assumes micro-cracks may form while the cells are producing power	No	No	Yes
Assumes conventional solar panels may be intermixed	Yes	No	Yes
Assumes cables will be disconnected while producing power	No	No	Yes
Assumes cables will be shorted while producing power	No	No	Yes
Assumes dirt will be allowed to accumulate on the panel due to dew and gravity	No	No	Yes
Assumes panels may be installed with morning/afternoon row to row shading	No	No	Yes
Nonstandard Requirements			
Utility must approve for installation	No	Yes	No
Requires per panel temperature sensor	No	Yes	No
Requires separate proprietary multicontact, active socket attached to each panel	No	Yes	No
Requires proprietary power cable and connector	No	Yes	No
Installs differently than conventional solar panels	No	Yes	No